

# Comparison of common filter media and thermal protocols used in EC – OC analysis

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## Introduction

The European Commission, with Mandate M/503 of April 2012, charged the European Committee for Standardization (CEN) to elaborate a **European Standard** and develop standardized methods on the measurement of airborne elemental carbon and organic carbon in PM2.5. The mandated work included a literature review, **laboratory research**, field validation tests, data evaluation and a project coordinator.

The laboratory research included, among others, tests on:

**filter media**, **thermal protocols**, long term stability, **filter handling**, temperature offsets calibration, filter homogeneity, **organic carbon pyrolyzation**, **pre-oxidation**, operational limits, comparison exercises, laser stability and laser intensity.

## Methods

Three common type of filters were selected for comparison: **Whatman QMA**, **Pall Tissuquartz 2500-QAT** and **Munktell MK360**.

Three identical Derenda sequential low volume samplers were installed at the A10 Ring Zuid highway monitoring site of the Air Quality Monitoring Network of Amsterdam. Each sampler was loaded with 15 filters of one type, 7 of which field blanks, and was set to sample 2.3 m³/h ambient air through an EU PM2.5 inlet for 8 periods of 24-hours. The filters remained in the sampler for another week in order to simulate the 15th day sampling cycle and field blank exposure routinely applied by monitoring networks. Two subsets of filters were handled and analyzed by a different approach: The first subset followed the handling and weighing procedure as described in EN 12341:2014 while the second was stored directly to petri slides until EC-OC analysis.

EC-OC by Thermal/Optical Carbon Analyzer (Sunset Laboratory): **EUSAAR2**, **NIOSH870** and **IMPROVEA**.

## Results

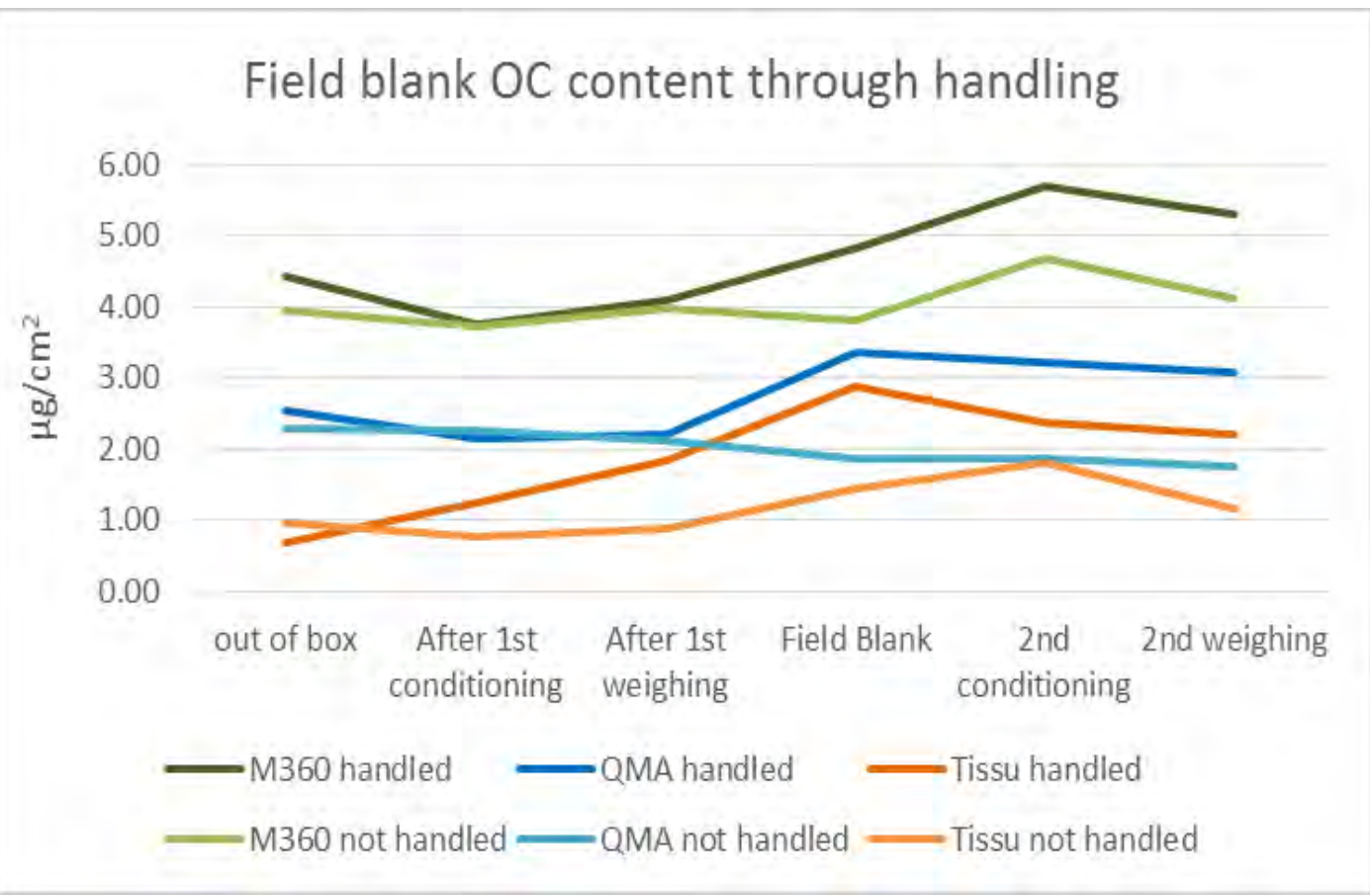


Figure 1. OC concentrations comparison for blanks per filter type, through handling procedure (conditioning and weighing) or direct analysis.

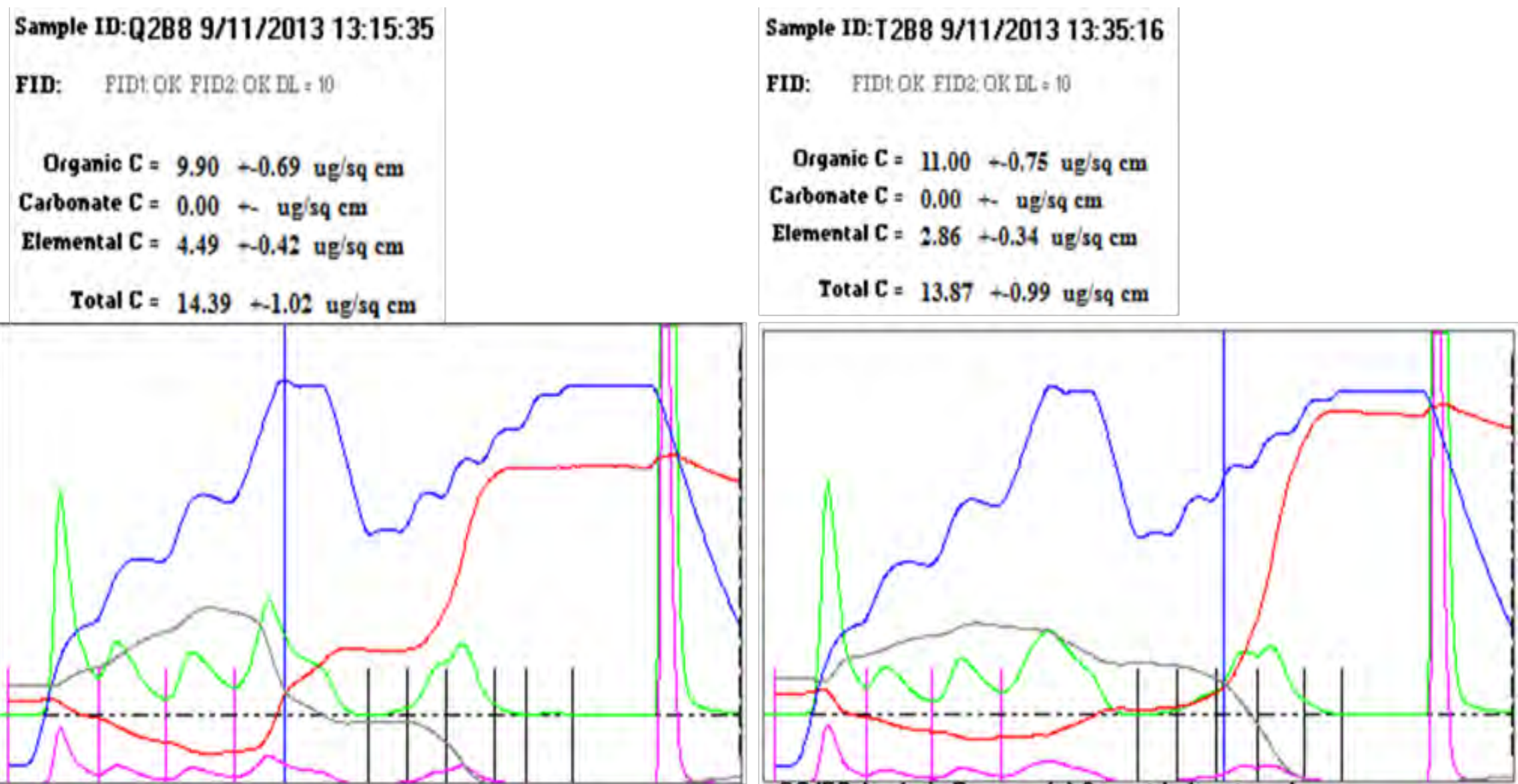


Figure 2. Comparison of thermograms of EC-OC analysis on PM2.5 loaded filters sampled on Whatman QMA (left) and Pall Tissuquartz 2500-QAT (right) with the use of NIOSH870 temperature protocol and TOT mode.

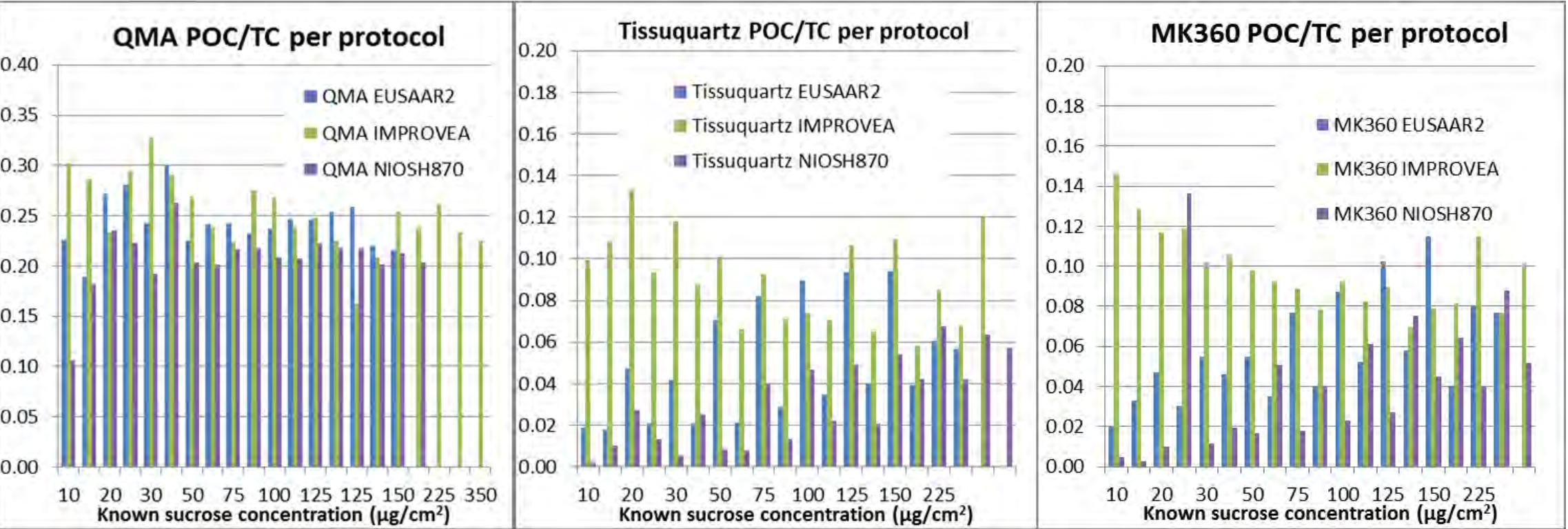


Figure 3. PC to TC ratios of known sucrose solution concentrations per filter media and temperature protocol on TOT mode.

## Conclusions

OC concentrations in blanks may vary per filter type, manufacturer, batch and/or filter (Figure 1).

The box blank OC may or may not desorb from the filter material through sampling, thus, subtracting the field blanks values from ambient concentrations is not recommended.

$TC_{Munktell} < TC_{Tissuquartz} \approx TC_{QMA}$  (Table 1 – Figure 1).

**Field exposure, handling and/or conditioning of a blank filter may alter the initial OC concentration.** Evaluation is suggested per filter type and each handling-conditioning step (Figure 1).

$EC_{NIOSH870} < EC_{EUSAAR2} < EC_{IMPROVEA}$

$PC_{NIOSH870} < PC_{EUSAAR2} < PC_{IMPROVEA}$

$PC_{QMA} < PC_{Tissuquartz} < PC_{MK360}$  (Table 1 – Figure 3)

The use of filters containing high concentrations of metals and /or binding material should be avoided. **The PC/TC and EC/TC alter when such a filter is used due to pre-oxidation of PC and/or EC during the inert phase** (Figure 2 – Figure 3).

## Acknowledgements

The current work was performed within the laboratory tests, part of the mandate for the development of standardized methods on the measurement of airborne EC and OC in PM2.5 and for the elaboration of a European Standard (CEN / TC264/WG 35).



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Table 1. OC, EC, TC and pyrolytic carbon (PC) concentrations in  $\mu\text{g}/\text{cm}^2$  averaged per protocol or filter, determined by laser transmittance (TOT).

	OC	EC	TC	PC
ImproveA	8.8	6.2	15.0	2.0
EUSAAR2	9.1	5.9	15.0	1.9
NIOSH870	10.0	5.0	15.0	1.3
Tissuquartz	8.8	5.7	14.6	1.9
MK360	10.6	5.6	16.3	2.2
QMA	8.5	5.7	14.2	1.1